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Input–Output Matrix study: A theoretical frame to study the impact of Brazilian IPI reduction in final demand☆

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Abstract

The economic crisis of 2008–2009 will be known as the day when the creator knelt before its creation (Syll, 2010). Amid such economic mess created by economists (and so-called engineers) themselves, there seems to be a single economic perspective: every man for himself and save yourself if you can. In the midst of this major disruption in the global economy, the Brazilian government decided, in a set of economic measures, to promote a partial and time-limited VAT reduction as its main countercyclical policy. This paper proposes to measure which were the direct and indirect effects of lowering the taxes for a limited time on production, employment generation and income. Additionally, it intends to check whether the reduction on IPI level, a tax that is one of the VATs in Brazil, was indeed the most efficient choice among the other value added taxes in Brazil. In order to accomplish such objectives, a simple final demand model for the GDP is adopted, and the latest national accounts input–output data is taken as a basis to infer the multipliers for the variables chosen and to estimate hypothetical impacts of reduction in other taxes instead of IPI reduction in the specific sector. Currently, the consensus is that the countercyclical economic policy adopted in Brazil had a positive result and fulfilled the expected goals.

JEL classification: E0; E2; E6

Keywords: VAT; IPI; Consumption; Employment; Product; Brazil; World crisis

Resumo

A crise econômica mundial de 2008 ficará conhecida como o dia em que o criador se ajoelhou diante da sua criação (Syll, 2010). Em meio a um cenário econômico de crise criado pela própria engenharia econômica de Wall Street, se observava uma ausência de políticas econômicas capazes de enfrentar o problema. Em resposta à crise econômica global o governo brasileiro optou por promover um conjunto de medidas econômicas anticíclicas, dentre as quais a redução parcial e por tempo limitado do IPI.

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Este artigo propõe fazer uma estimação dos efeitos, diretos e indiretos, da redução do imposto sobre produtos industrializados (IPI) sobre a produção, a geração de emprego e renda. Ele também pretende verificar se a redução do IPI – um de nossos impostos na forma de imposto sobre o valor agregado (IVA) – foi a mais adequada para atingir os objetivos da política anticíclica.

A fim de cumprir esses objetivos, foi elaborado um modelo simples de estimação da demanda final a partir do PIB e dos dados da última matriz insumo-produto estimada para inferir os hipotéticos impactos da redução do IPI sobre alguns setores da economia.

Atualmente, é consenso que a política econômica anticíclica adotada pelo Brasil alcançou um resultado positivo e cumpriu com os objetivos esperados.

Palavras chave: IPI; Consumo; Emprego; Produto; Brasil; Crise mundial

1. Introduction

The global crisis of 2008 is a milestone in Brazil's recent history. In recent decades, the economic policy implemented in Brazil in moments of crisis had generally been pro-cyclical. The historically high foreign vulnerability forced the increase of the basic interest rate to prevent capital flight, generally counterbalanced with greater fiscal austerity – in other terms, cutting public expenditure (Barbosa and Souza, 2010).

Given the new macro-structural conditions of the country and the present economic orientation, the response to the crisis was countercyclical (BNDES, 2009), especially from the point of view of tax policy, following the international response bashfully (CEPAL, 2009). All around the world, State intervention was perceived as an erroneous mechanism that lacked prescriptions from neo-liberalism.[1]

When focusing these actions, it is important to evaluate the potential effectiveness of such measures. This work is devoted to this task, in particular to examine the probable results of the policy of tax reduction (IPI) implemented by the Lula Government in 2008–2009 as a response to the global crisis, using input–output analysis.

Before moving on to explain the analysis framework and the tools developed, it seems appropriate to briefly underline how the crisis translates into various shocks to the Brazilian economy. As notes Araújo, "the main channels of transmission of the international crisis for Brazil refer to credit, decrease of trade and global demand and expectations" (Araújo and Gentil, 2010).

A brief first task is to summarize how the crisis is transmitted to aggregate demand of the Brazilian economy, with severe negative impact. The decrease in final demand from the side of exports demand is accompanied with a worsening of investment expectations in conjunction with credit crunches at the heights of panic events during the crisis, and also in general by the global deleverage that has been happening since the onset of the crisis (Gonçalves, 2009). The impact on investments is also seen (Domingues et al., 2010), and both weaknesses are translated and spread through the whole internal economy as less production, tax income and employment level, which in turn can decelerate both government revenue, expenditure and internal final demand (IPEA, 2009b).

The effects, it is worth mentioning, are cumulative, leading to a recursive fall in tax collection, and, depending on its force, could even trigger a deflationary spiral.[2]

A countercyclical monetary policy, in response to shocks like this, involves the injection of liquidity – including the diminution of the interest rate and credit provision to the most affected actors by international contraction. With some delay and hesitance regarding interest rate policy loosening, due mainly to the tacit independence of the Central Bank of Brazil and its sole focus on controlling inflation, such measures were progressively put into place (IPEA, 2009a).

Our focus, however, is about the impact of fiscal policy as a counterweight to the crisis. One of the implicit assumptions of any proposal to reduce a VAT (value-added tax) is that it acts positively on consumption demand, by the impact of price reduction for the final consumer, partially offsetting the drop in exports with an increased

[1] As the minimum State intervention into the economy, and the tripod privatization, liberalization and de-regulation, in a context of permanent adjustment (see for example Arrizabalo, 2001). Concerning the recent macroeconomic model or policy developed in Brazil, it is recommended the suggesting article of Filgueiras et al. (2010).

[2] This risk in the current crisis was low, based on the actual expansionist monetary policy and the response to the crisis taken by the United States, beholder of the global reserve currency.

domestic demand (Manente and Michele, 2010, p. 407). Finally, the impulse for sales would be indirectly reflected in the production which, because of the interdependence of the system' sectors (a main focus of input–output approach), would result in a positive effect on other components of Final Demand, among other investments. Finally, the positive effects would result in augmented tax revenues, by the increase in consumption and production, counterbalancing the initial fall in tax income.

Given this abstract and general framework for dealing with the matter, the next section centers on the specific analysis for Brazil's case, looking to clarify important points about the Brazilian tax structure and the context where the countercyclical fiscal policy was developed.

2. Tax policy and the crisis in Brazil

This section aims at covering two goals: the first is to briefly describe the tax structure of Brazil with regard to value-added taxes like IPI. The second objective is to outline the IPI cutback that occurred in 2009 and extract important elements of the context to be taken into account when creating the analysis framework, or a base model.

2.1. Value-added taxes in Brazil

In Brazil, unlike in Europe, we find three main taxes on products: ICMS (tax on circulation of goods and services), IPI (Tax on Industrialized Products) and ISS (Tax on Services). These taxes together are similar to a VAT (value added tax).

The overlapping of taxes and particularly the main importance of indirect and regressive taxes are historical marks of the fiscal structure of the country. This form of taxation puts the country, according to the Brazilian Institute of tax planning – IBPT in 14th place on tax collection, being one of the countries with the highest gross tax burden in the world.[3]

The VAT is a tax type used in the vast majority of OECD countries, such as all that form the EU (despite name changes in some countries, VAT is the term for most of them), United States, England, Scotland, Ireland (where it is known also as CBL), Australia (called GST – Goods and Services Tax) and Canada (where there are the GST and HST – Harmonized Sales Tax).

Among the classic advantages of value-added tax are better monitoring, since the actors of the supply chain acquire the role of collectors, and the fact that yet, with multiple collectors, this kind of tax avoids bi-taxation of cascading sales tax, which value-added taxes come to replace.

In Brazil the largest representative of the three taxes cited is the ICMS. Its collection is the competence of each State of the Federation and its level is around 17%, similar to the level of the aliquot commonly found on the international ground, around 17.5%. In 1966, when it was created, it was given the name of ICM, replacing the IVC – sales and consignments tax.[4]

At the same time (1964–1967, period of reforms during the military dictatorship) the IPI – Tax on Industrialized Products – was created. It was another value-added tax, which came to replace IC – the existing Tax on Consumption then. This tax is the responsibility of the Central Government, hence its use from its creation as a tool for sectoral industrial policy by the Federal Government (Castro et al., 2010, pp. 182-185)

Due to the option to act during the crisis using IPI, here we only focus on the adopted policy in relation to this tax. From December 2008, the Government created multiple timelines for IPI reduction, reducing the tax rate to some products, exempting others, keeping or removing the benefits, depending on the resumption of economic "normalcy". Some products, such as stoves and "tanquinhos",[5] had the IPI rate reduced to zero. Let's look more closely at the governmental action in this field in the beginning of the current global financial crisis.

[3] It should be recalled that net taxation, however, is less than 11% of GDP – discounting income transfers such as social assistance and welfare, and mainly the interest payments and debt burden (Bastos and Rodrigues, 2010).

[4] The IVC was a cascading sales tax. It was replaced by the ICM, which incorporated 5 other indirect taxes (Oliveira, 1981), and was transformed into ICMS when the Constitution of 1988 was promulgated.

[5] A type of low-cost washing machine commonly found in Brazil.

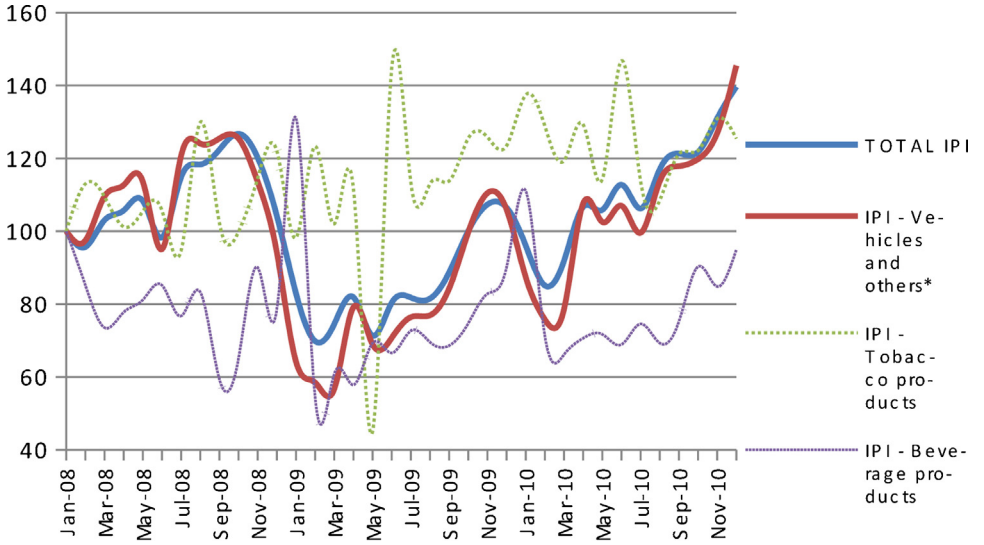

Fig. 1. IPI sectoral incomes – 2008–2010. Elaborated by the author based on data from Brazil's National Treasury (Jan/08 = 100). *Excluding IPI on imports – approximation to the sectors with fiscal benefits. (For interpretation of the references to color in the text, the reader is referred to the web version of the article.)

2.2. *The Brazilian response of economic and fiscal policy to the crisis*

Fiscal policy designed and executed to counteract the crisis in Brazil was centered on a set of tax reliefs associated with the maintenance of public expenditure. Since December 2008 the automotive sector enjoyed substantial reduction in IPI to be collected.[6] The reduction was renewed successively and quarterly until the total accumulated time of nearly one year.

From March 2009, similar policy was extended to the sectors of white line appliances and building materials.[7] Both sectors had quarterly reductions at first, having their discharge enactment time span renewed repeatedly afterwards, following the same pattern as of the IPI policy. For electric appliances/white line the whole period lasted 10 months. For the various building materials covered in similar policy measures, changes lasted about 15 months (Barbosa, 2010).

Moreover, as said, the maintenance of public expenditure, so as not to neutralize the positive impacts of the tax relief, was contemplated by lowering the target of the fiscal primary surplus from 4.3% to 2.5% of GDP for 2009. Thus, the impact of reduction of taxation (T) in less alternative public expenditure capacity was virtually cancelled.

In March 2009 the Government was promoting IPI level reductions and increases according to the signs of the economy, and this constituted in consumers' minds short-term and limited measures that were cut or extended according to Government planning. That month the benefit of IPI reduction was extended for vehicles, and instituted for building materials and appliances (refrigerators, washing machines, stoves and "tanquinhos"). On the other hand, the cigarette tax was increased to partially compensate for the loss of tax revenue by the Government, once again acting to compensate revenues lost with the anti-cyclical policy.

Fig. 1 shows how the total collection of IPI varied during the crisis. The period when deepening of the world crisis and implementation of the policies discussed concurred is the one between the two vertical lines. Note that there was significant reduction in tax revenue, due mainly to the performance of sectors with countercyclical fiscal policy (red line). Tax revenue performance in smoke and drink sectors, as can be seen, would not explain the variation in the collection.

[6] The reduction of the rates of the IPI was 100% on cars with maximum 1000 cm^3 engine capacity (from 7% to zero) and 50% on cars between 1000 cm^3 and 2000 cm^3 engine capacity (13–6.5% for gasoline cars and 11–5.5% for cars on ethanol/flex fuel). Similar reduction rates also applied to pickup vehicles and similar (light commercial) (IPEA-DIMAC, 2009).

[7] From the end of 2009, there was also specific fiscal policy for the furniture sector. However, by the significant difference in time between the deepening of the crisis (2008) and the beginning of these policies, we opted not to consider them for this study. The increase in IPI on tobacco products is neither taken into account in this analysis, since, in itself, it does not constitute a countercyclical policy.

After having clarified the actions regarding the fiscal policy which fall in the focus of this study, in the next section we will explain the construction of the analysis framework, based on a simulation from tables of input–output for the Brazilian economy.[8]

3. Analysis framework

The lack of updated data (Guilhoto, 2011, p. 20) that would enable to sufficiently assess the real effectiveness of economic policy measures cited has made it necessary to build a model to evaluate its potential efficacy.

The last input–output tables, made available by IBGE with 55 × 55 activities, are from the year 2005.[9] But NEREUS Group provides updated estimations of new Input–Output Matrixes, which, for the purposes of this study, remain very similar to original ones available (Guilhoto, 2010). Thus, we shall use their 2008 estimated tables.

> "*Therefore, we can assert that the values and orders of economic indexes calculated are not different between the estimated and original matrixes. The results indicate that it is possible to produce structural analyses of the economy using the estimated matrix according to the proposed methodology, and arrive to the same conclusions as if using the matrix published by 'Instituto Brasileiro de Geografia e Estatística'.*" (Guilhoto and Sesso, 2010, *p. 57, translated by the present authors)*

During the last centuries economists such as William Petty (1623–1687), Richard Cantillon (1697–1734), and François Quesnay (1694–1774) through their work tried to disseminate the wide range of applications in economy of methods that later gave birth to input–output methodology. It was, though, with Wassily Leontief (1905–1999) that applications of Matrix Algebra were faster spread in the field of economic science. From his method it was feasible to capture impacts of economic shocks. In that comprehensive appraisal, his developed methods and ideas are considered by many as a composition of fisiocratic,[10] walrasian[11] and marxist[12] ideals. Therefore, Leontief's inverse was established as an efficient method of estimation of direct and indirect impacts of changes in economic variables.

Without losing the focus on the intent to unify theory and practice, Leontief contributed in innovative ways to areas such as automation, deforesting, environmental sciences, international trade, spatial and global analysis (Guilhoto, 2011). Input–Output Matrixes, constructed from data included in National Accounts, became powerful mathematical tools for estimations. Its usefulness was multiplied when they started to be incorporated into general equilibrium and econometric models (Azzoni and Kadota, 2010). Even though input–output models can be turned into dynamic ones, static models, such as the one created for this study, are more practical and applicable with fewer restrictions, being more widely applied.

Among the available data we find a column vector of the IPI (denoted by i), separated by activity. Thus, the first step in the analysis was to create a vector r of relative reductions for each activity (see Appendix A), on the basis that the reduction, for simplification purposes, has been in all cases of one year. From there, we make simply:

$$i * r = i_1 \tag{1}$$

It is important to note that the impact of a tax on consumption in output cannot be measured directly, so intermediate assumptions connecting that tax lowering to demand are necessary. In some cases or studies,[13] this involves undergoing a modeling approach from income-elasticity and price elasticity for products/sectors.[14]

[8] These estimations could be extended to estates/provinces building on regional models. For more details see Haddad et al. (2002).

[9] IBGE computes Leontief Matrix from Tables of Resource and Uses of national accounts, assuming the hypotheses of industry technology, and distribution of the demand for constant market-share. In a similar approach, Guilhoto and Sessa and the NEREUS group estimate Leontief inverses from Brazilian National Accounts for years when IBGE hasn't yet published Input–Output tables.

[10] Based on François Quesnay's "*Tableau Économique*".

[11] As an adaptation of León Walras's general equilibrium supply-demand equations for the various sectors.

[12] Leontief, in his works, analyzed also problems of forms of socialist planification implemented.

[13] See (IPEA-DIMAC, 2009) or (Manente and Michele, 2010, p. 407).

[14] In this study it was not possible could not proceed to this form of practice because: There are not studies available on all sectors and their income and price elasticities. IPI tax was lowered for goods that are part of the sets defined as activities or products in the Input–Output, which would make needed yet another mediation to be able to apply this approach using the Input–Output tables.

Table 1
Impacts on supply of lowering IPI.

	Scenario 1 (%)	Scenario 2 (%)
Initial fiscal income lost (% GDP)	0.17	0.17
Impact on GDP	0.12	0.28
Impact on total production	0.20	0.48
Increase in vehicles output	4.06	9.01
Increase in bus and trucks output	0.56	5.34
Increase in appliances output	5.04	9.81
Increase in cement for construction purposes[a]	0.13	0.61

[a] Taken as representing building materials for being more clearly devised on economic policy measures.

The hypotheses adopted in this study are simplified, based on the construction of two scenarios. The first is that the reduction of IPI, for being limited in time, is fully transmitted to the final demand for the benefited goods, and that public spending remains constant:

$$Df_1 = Df_0 + i_1 \tag{2}$$

$$G_1 = G_0 \tag{3}$$

The second scenario recognizes the effect of price reduction caused by IPI as responsible for a demand increase of 5%, in line with other studies (IPEA-DIMAC, 2009), and compatible with the relative magnitude of the tax. In other terms:

$$Df_2 = 1.05 * Df_0 + i_1 \tag{4}$$

$$G_2 = G_0 \tag{5}$$

The analysis of the results assumes that the actual impacts were most probably between the first and second scenario. In the following section we focus on assessing those forecasts.

4. Assessment of the impacts of reducing the IPI rate

The analysis of the impacts of IPI reduction in automobiles, white line of appliances and building material was divided, for better clarity, in the areas of interest of the article. They are: production impact, impact on consumption, impact on employment and evaluation of alternatives.

4.1. Impact on production

With the data obtained by simulation based on the input–output model (see Appendix A), we can observe that impacts on production are significant, particularly when compared to the size in proportion to GDP of tax waiver.

As we show in Table 1, for a gross tax waiver only about 0.17% of GDP, the impact on total production achieved was between about 1.2 and 3 times the tax income loss, in reasonably conservative analysis. The result could mean increasing total production by slightly less than 0.5% in the most favorable forecast, which in turn would result in an increase in up to 0.28% to GDP.

From a sector point of view, the production of automobiles is the one that presents the greatest impact, with an increase of 4.06–9.01%, according to the scenario considered, as well as the appliances industry (between 5.04 and 9.81% increase). The production of trucks and buses is the one, after cement for construction purposes, that would receive the least impact resulting from the reduction on IPI rate, partly because there was already a low rate before reduction has taken place.

Table 2
IPI policy – impacts on employment.[a]

	Scenario 1	Scenario 2
Overall impact on employment	69,444	162,556
Vehicles	46,349	102,785
Direct jobs	3,676	8,158
Indirect jobs	42,673	94,626
Trucks and buses	2,046	19,643
Direct jobs	138	1,323
Indirect jobs	1,908	18,320
Appliances	7,968	15,497
Direct jobs	2,672	5,200
Indirect jobs	5,296	10,297
Cement	166	765
Direct jobs	23	108
Indirect jobs	143	658
Paints and varnishes sector	423	949
Direct jobs	112	252
Indirect jobs	310	697
Rubber and plastic	5,242	12,868
Direct jobs	2,516	6,182
Indirect jobs	2,725	6,686
Electrical Machines	3,234	6,569
Direct jobs	1,330	2,704
Indirect jobs	1,904	3,865
Furniture and related	4,018	4,429
Direct jobs	2,933	3,235
Indirect jobs	1,085	1,193

[a] Estimated according employment multiplier (Guilhoto et al., 2010), adjusted to avoid double counting (% of total employment maintained with double counting totals).

Finally, albeit with significant impact, in absolute terms the policy of reducing IPI shows to be insufficient as unique policy against the crisis. This is due to the magnitude of the crisis, under which the perspectives of negative impacts to growth could be of 5% or more.[15]

4.2. Impact on employment level

Because of the nature of the adopted assumptions, the impacts on labor that can be clearly devised from the model are those relative to total and sector employment levels.

As shown in Table 2, the cited measures would create or retain from about 70,000 jobs to 160,000 jobs in one year. The largest contributor to this would once again be the vehicle industry. That is explained, on one hand, by the size that the sector represents (being the greatest of all studied, with total output greater than the sum of sectors of appliances, trucks and buses and cement), and, on the other hand, by the density of its chaining through the whole economic system (Cecchini, 2005), since, as seen in the table, direct job creation would be quite modest (between 3.6 and 8 thousand direct jobs created).

The industry with second greatest direct contribution to employment would, nevertheless, be the rubber and plastic production, with direct potential creation of nearly 6200 jobs. However, its chaining derived from input–output data is quite low, which puts the industry's total contribution below the appliances sector. The cement sector, given the assumptions taken into account, had an almost negligible contribution.[16]

[15] In fact it was not the only policy adopted by the Brazilian Government before the crisis, having been complemented by injection of liquidity, credit provision and public investment programmes.

[16] A possible modification to include assumptions about investment could certainly change this result, since the construction sector, a large consumer of cement, is strongly labor intensive See, for example, Campos and Garcia (2010).

Table 3
Impacts on consumption.

	Scenario 1 (%)	Scenario 2 (%)
Impact on final consumption	0.20	0.35
Vehicles final consumption	4.06	9.10
Bus and trucks final consumption	0.56	5.56
Appliances final consumption	5.04	10.29
Cement final consumption[a]	0.13	5.89

[a] Taken as representative for construction materials.

In next section the impacts on consumption will be evaluated. After that, we finish the analysis by comparatively and qualitatively assessing the effectiveness of reducing the IPI tax instead of an alternative one.

4.3. Impacts on consumption

A great number of studies have tried to estimate the impacts of fiscal incentives on consumption, mainly those applied to the vehicles sector.[17] Table 3 summarizes the impacts of household consumption derived from the simulation. In it, it's possible to see that the increase in household consumption of cars, vans and light-commercials could range from 4.5% to 9.1%.[18] However, the industries' largest relative increase in private consumption would be in appliances, in which the positive variation would have been between 5.04% and 10.3%.[19] Finally, note that the performance at the final consumption in the case of trucks and buses is quite dependent on the possible impacts of tax reduction to demand. We conclude by looking at the wide variation between the calculated scenarios; the same applies to cement consumption.

4.4. Comparative analysis of the effectiveness of the policy

Some criteria to benchmark and qualitatively appraise the choice of reducing IPI as fiscal policy seem at this point imperative. Thanks to the study done in terms of input–output analysis, we can clearly devise important factors to use as a basis for such a task.[20]

Taking into account the labor market, the first factor is about direct potential, measured by the number of jobs generated from each monetary unit of increase in production. A second is about the chaining potential of the sectors chosen, which leads us to the question of indirect effects.

From a more general point of view, another important factor is whether the engine derived from the reduction in terms of, for example, increased demand, is feasible and highly probable.

When we consider such factors, we can devise that some sectors, like agriculture and services, are more labour intensive than the sectors actually chosen. And, in terms of chaining (inter-sectorial) potential, some activities in services seem to have more potential. That can be seen clearly since a homogeneous increase in demand (0.39%), for example (with the same total increase), would create 2.5 times more jobs.

But it is important to remember the real options at hand for policy makers. Firstly, as seen through scenario 2, impacts on additional demand significantly leverage the effects according to the model. So it was crucial to aim at products/sectors with great price-elasticity.[21] This is an important point in favor of the option of an industrialized tax unrelated to food or agriculture sectors. Also because of the external limitations, it appears it would be innocuous to aim at products intended for export, since foreign demand was shrinking importantly.

[17] See Amann et al. (2007) for a comprehensive study on this subject.
[18] This increase matches closely the estimates of technical note of Brazil's IPEA – Research Institute of Applied Economics (IPEA, 2009).
[19] This could be seen as a certain inadequacy of simplified hypotheses to the reality of the industry, since it means an aggregate elasticity impact of more than 1.
[20] It is important to note that investment was not deeply considered in this study. It certainly is an important element to be included in a broader analysis, but it's out of the scope of this work.
[21] No less important is the fact that the policy focused on sectors that had power to ensure that the reduction would be transmitted mainly to the final price.

Finally, in the practical arena, the IPI is the only one of the three value-added taxes in the country which is the responsibility of the Central Government. The ICMS is managed at the state (provinces) level, and the ISS is municipal jurisdiction. The effort to harmonize these policies in times of crisis, when it is known that even in times of serenity this has been difficult to accomplish, would seem risky at a time that required urgent action.

5. Concluding remarks

Input–output analysis is quite relevant for cases as the one focused on to assess impacts of economic policy in the overall economy. It allows one to think about key elements to draw and evaluate policies, by dividing the results clearly.

This study showed how important the price-effect is to measures whose influence is outside the matrix of intermediary coefficients.

Finally, the policy pursued has had, according to the estimations, significant effects compared to the amount of the tax waiver, but clearly insufficient if thought of as single action (something that has not happened).

Among the alternatives and the margin of maneuver available for the Brazilian Central Government, the IPI reduction option for the sectors listed seemed a good choice, if compared to other strategies aiming at lowering VAT-type taxes in the country.

In the near future, it will be possible to check with real data on the effectiveness of such a policy, in a retrospective manner.

As for the available data and estimates, the model presented good results. Even with fairly simplified hypotheses, it is interesting to note that the relative reduction predicted for a year in the model for vehicles, 60.80% (the most studied sector in various forums) is adjusted very well to the reality of tax collection during 2009 (falling in nominal prices 67%, which means something less in real terms) – something verified ex-post. The contribution of 50,000–105,000 is also in the same direction of the estimate made by IPEA (in a much more simplified framework) of 50,000 or 60,000 posts in one semester.

Appendix A. Vectors and matrices

This section focuses on explaining the peculiarities of the I–O tables for Brazil, as well as the assumptions used for the simulation and results.

A.1. The Brazilian Input–Output Matrix

Since it is a construction dependable on some assumptions, it is important to note how to get to the Input–Output Table, from the official standard methodology.

Brazil's I–O table is built upon the Table of Resources and Table of Uses from the system of national accounts of IBGE.[22] From the Table of Resources, it is possible to obtain the Total Supply at basic price and the Total Product, as shown in IBGE (Technical Notes about TRU). It is important to note that at this point the base tables are tables of product × activities (110 products × 55 activities, plus auxiliary lines and columns) (Fig. 2).[23]

$$\mathrm{TSPP} = \mathrm{TSCP} - \mathrm{TdM} - \mathrm{TrM} - \mathrm{IT} - \mathrm{IPI} - \mathrm{ICMS} - \mathrm{OT} \tag{6}$$

The Table of Uses, in turn, provides us the Total Demand at consumer prices, including imports. The division of imports is made allocating demand products proportionately to the activities that produce it.[24] So to be able to unite the values of supply (resources) with the demand (uses) based on the basic price and only for domestic production, imports and taxes must be taken out of demand.[25]

[22] Instituto Brasileiro de Geografia e Estatística.

[23] Total Supply at Producer Prices = Total Supply at Consumer Prices – Trade Margin – Transport Margin – Import Tax – IPI – ICMS – Other Net Taxes.

[24] See Technical Notes – TRU in IBGE (2008).

[25] This is done with the assistance of the ERETES software used by IBGE for national accounts.

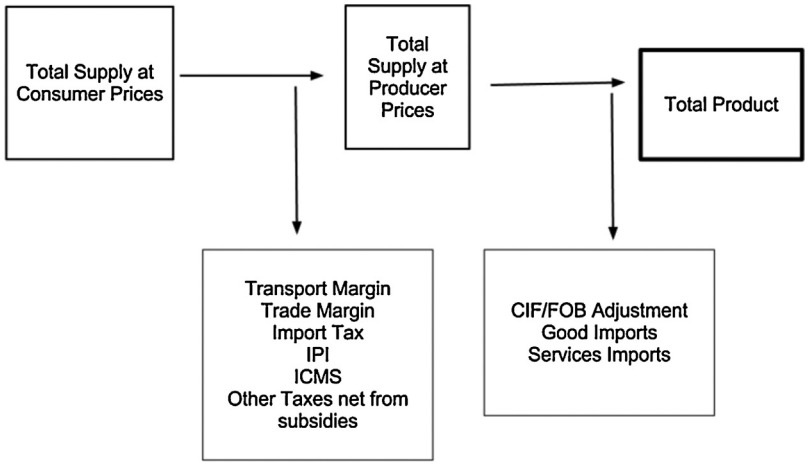

Fig. 2. From total supply to total product (X).

As a result:

$$Dt_{pb} = (Dt_{pc} - D_M) - T_{Dt} \tag{7}$$

But the matrix of Intermediate Consumption compatible with Leontief's approach, as seen below, is in the form of $n \times n$:

$$\Delta X_{(N\times 1)} = (I - A)^{-1_{(N\times N)}} \cdot \Delta Y_{(N\times 1)} \tag{8}$$

Being: $(I-A)^{-1}$ Leontief inverse matrix; ΔY, final demand variation; ΔX, variation of total production.

However, the presentation of the data of IBGE is, as said, in the form of 110×55, since the set of products is not merely a subset of the set of activities, one that could be grouped by simple addition. An activity can produce different products from different industries. So there is one mediation missing. To solve this a model of simple industry-technology is adopted for the calculation of the I–O tables, without by-products. This means that to build a 55×55 matrix from the 110×55 that is available, technology of the industry is translated into constant market-share. That is, understanding that the demand for each activity for each product remains fixed.[26] So we have to create from the Table of Resources a matrix of "market share" D, where:

$$D_{ij} = \frac{o_{ij}}{x_j} \tag{9}$$

The value of production vector (x) is taken from of gross income (a line vector in Payments), which is the sum of total value added, remuneration of factors and taxes,[27] and each element is taken from the original table, the Table of Resources.

Finally, multiplying D by the matrix of technical coefficients derived from Dt_{pb} (obtained with the same calculus as D), we obtain an array of 55×55 activities by activity to, or A. From there on the Leontief-matrix calculation very well known.

A.2. Estimates and assumptions-basis for simulation

A major difficulty in order to undertake the simulation was to adapt the tax policy to an input–product model with available data. The reason is that the fiscal easing was made on specific products and, at greater disaggregation level of data than the disaggregation by 110 products available. Therefore, estimates were necessary to see the impact of these reductions in the tax rate on what would be the activity to which they belong.[28] These estimates, summarized in

[26] With fixed demands, technical coefficients by activity are constant and equal if one takes the Table of Resources and de I–O table.
[27] This is a note with it is taken as a factor of harmonization, justified by the hypothesis.
[28] For that we assumed that each benefited product belonged only to one activity.

Table 4
Estimation of relative reduction of IPI revenue for activities.

Products/sectors	Trucks and buses (%)	Appliances (%)	Vehicles (%)	Cement (%)	IPI (%)	Average reduction of IPI (%)	Reduction (% total act.)
Trucks e buses					4.9		76.1
Trucks	74.2				5.0	100.0	
Cars, light-commercial and pickups					8.7		60.8
Cars up to 1000c			34.2		7.0	100.0	
Cars 1000/2000c			50.0		11.5	50.0	
Appliances					12.1		61.6
Refrigerators		35.7			15.0	66.7	
Stoves		16.8			5.0	100.0	
Washing machines		17.1			20.0	75.0	
"Tanquinhos"		5.0[a]			10.0	100.0	
Others					4.0		71.1
Cement for construction[b]				71.1	4.0	100.0	

Estimated by the authors from data of PIA-IBGE (Annual Industrial Research) and IPI-incidence table (Federal Fiscal Agency).
[a] Estimated.
[b] Estimated from the IOT.

Table 4, were made as follows. For vehicles, trucks, appliances and cement, estimated directly by Annual Industrial Research (PIA) IBGE and sectoral data support (as of Albergoni, 2009; ABIMAQ, 2006; ABINEE, 2010; Anfavea or Eletros[29]) to estimate the relative weight of each product in the activity. The average IPI in relation to total production for each activity was estimated with these data and auxiliary with the I–O data, and then, it was possible to obtain the equivalent percentage of reduction of IPI in each activity.

On the other hand, various building materials products, whose tax relief was about 90%, were products whose membership to activities was not even directly possible from the data of the PIA. For them, we identified the activities to which they belong and arbitrated that the IPI would drop 10% (see items in red in Table 5). Finally, the vector r was calculated, and vector i_1, as indicated in Section 3.

With these restricted hypotheses, two scenarios were defined, based on simplified assumptions, understanding the feasibility and likelihood that actual results would stand between both scenarios. Both scenarios considered constant the Exports and Government consumption (the first by the crisis, the second by the package of government action, as we seen in Section 2.2).

The first scenario, more conservative, assumes that the tax cut is converted into Final demand for the same sectors, since the limited tax reduction was perceived as a discount, being disseminated widely as temporary opportunity.

The second scenario, in addition to the factor income as designed in the first, adds to sectors for which it was possible to make precise specification of reduction of the IPI (vehicles, trucks, appliances and cement), an increase of final demand by 5% by effect of this "temporary discount" as a price-effect.

Appendix B.

See Table 5 .

[29] Respectively National Association of manufacturers of automotive vehicles and the National Association of manufacturers of electro-electronics products.

Table 5
Summary of estimations.

Sector Code (Level 55)	Product Description (Level 55)	IPI REDUCTION MULTIPLIER	IPI Collected on Final Demand	Î	Df(2008)	Df1	X1	'+X1 (%)	'+L1	'+C1	Df2	'+X2 (%)	'+L2	'+C2(%X)
101	Agricultura, silvicultura, exploração florestal	0%	0,0	0,0	71.569,6	71.569,6	179.611,4	0,01%	1.666	0,00%	71.569,6	0,03%	3.658	0,00%
102	Pecuária e pesca	0%	0,0	0,0	33.373,3	33.373,3	99.804,2	0,00%	223	0,00%	33.373,3	0,01%	502	0,00%
201	Petróleo e gás natural	0%	0,0	0,0	25.135,1	25.135,1	110.038,4	0,09%	52	0,00%	25.135,1	0,21%	124	0,00%
202	Minério de ferro	0%	0,0	0,0	24.990,7	24.990,7	36.441,2	0,15%	56	0,00%	24.990,7	0,36%	134	0,00%
203	Outros da indústria extrativa	0%	0,0	0,0	4.611,2	4.611,2	19.849,2	0,17%	332	0,00%	4.611,2	0,40%	790	0,00%
301	Alimentos e Bebidas	0%	1.896,7	0,0	222.405,8	222.405,8	344.705,9	0,00%	108	0,00%	222.405,8	0,01%	252	0,00%
302	Produtos do fumo	0%	4.440,7	0,0	10.935,5	10.935,5	11.213,0	0,00%	0	0,00%	10.935,5	0,00%	0	0,00%
303	Têxteis	0%	27,0	0,0	13.783,1	13.783,1	41.153,0	0,04%	361	0,00%	13.783,1	0,08%	787	0,00%
304	Artigos do vestuário e acessórios	0%	0,0	0,0	36.250,7	36.250,7	39.332,0	0,01%	149	0,00%	36.250,7	0,02%	368	0,00%
305	Artefatos de couro e calçados	0%	15,0	0,0	21.082,1	21.082,1	26.795,3	0,02%	125	0,00%	21.082,1	0,04%	280	0,00%
306	Produtos de madeira - exclusive móveis	0%	9,3	0,0	5.402,9	5.402,9	22.593,0	0,11%	525	0,00%	5.402,9	0,18%	844	0,00%
307	Celulose e produtos de papel	0%	161,6	0,0	17.597,9	17.597,9	47.423,9	0,13%	270	0,00%	17.597,9	0,28%	578	0,00%
308	Jornais, revistas, discos	0%	64,1	0,0	11.060,3	11.060,3	37.615,1	0,09%	359	0,00%	11.060,3	0,21%	874	0,00%
309	Refino de petróleo e coque	0%	0,0	0,0	44.208,4	44.208,4	154.197,6	0,11%	27	0,00%	44.208,4	0,27%	65	0,00%
310	Álcool	0%	0,0	0,0	12.352,4	12.352,4	23.476,4	0,04%	64	0,00%	12.352,4	0,11%	153	0,00%
311	Produtos químicos	0%	0,0	0,0	7.304,8	7.304,8	81.186,5	0,16%	162	0,00%	7.304,8	0,38%	380	0,00%
312	Fabricação de resina e elastômeros	0%	0,0	0,0	4.227,8	4.227,8	28.868,9	0,42%	127	0,00%	4.227,8	0,98%	292	0,00%
313	Produtos farmacêuticos	0%	64,8	0,0	26.800,3	26.800,3	35.295,3	0,01%	8	0,00%	26.800,3	0,02%	18	0,00%
314	Defensivos agrícolas	0%	0,0	0,0	2.104,1	2.104,1	17.961,8	0,05%	11	0,00%	2.104,1	0,11%	23	0,00%
315	Perfumaria, higiene e limpeza	0%	2.189,9	0,0	18.988,5	18.988,5	23.670,7	0,02%	18	0,00%	18.988,5	0,04%	43	0,00%
316	Tintas, vernizes, esmaltes e lacas	10%	0,7	0,1	2.133,9	2.134,0	11.773,7	0,30%	112	0,00%	2.134,0	0,66%	252	0,00%
317	Produtos e preparados químicos diversos	0%	80,1	0,0	2.751,5	2.751,5	14.708,2	0,13%	112	0,00%	2.751,5	0,30%	260	0,00%
318	Artigos de borracha e plástico	10%	33,7	3,4	8.559,4	8.562,8	61.671,0	0,60%	2.516	0,04%	8.562,8	1,47%	6.182	0,04%
319	Cimento	71%	9,8	6,9	780,0	787,0	10.043,3	0,13%	23	0,89%	826,0	0,61%	108	5,89%
320	Outros produtos de minerais não-metálicos	0%	116,7	0,0	5.233,7	5.233,7	40.394,7	0,19%	1.152	0,00%	5.233,7	0,43%	2.656	0,00%
321	Fabricação de aço e derivados	0%	21,1	0,0	29.160,6	29.160,6	106.915,8	0,59%	798	0,00%	29.160,6	1,43%	1.920	0,00%
322	Metalurgia de metais não-ferrosos	0%	17,8	0,0	13.663,2	13.663,2	37.382,0	0,24%	302	0,00%	13.663,2	0,57%	706	0,00%
323	Produtos de metal - exclusive máquinas e equipamentos	0%	371,4	0,0	23.036,4	23.036,4	73.439,2	0,35%	2.876	0,00%	23.036,4	0,80%	6.597	0,00%
324	Máquinas e equipamentos, inclusive manutenção e reparos	0%	3.180,2	0,0	78.822,0	78.822,0	101.520,3	0,13%	754	0,00%	78.822,0	0,33%	1.864	0,00%
325	Eletrodomésticos	62%	990,2	613,9	11.613,7	12.227,6	12.960,7	5,04%	2.672	5,29%	12.808,3	9,81%	5.200	10,29%
326	Máquinas para escritório e equipamentos de informática	0%	359,3	0,0	20.246,7	20.246,7	22.569,1	0,01%	5	0,00%	20.246,7	0,02%	12	0,00%
327	Máquinas, aparelhos e materiais elétricos	10%	576,5	57,6	16.927,8	16.985,4	48.222,2	0,52%	1.330	0,34%	16.985,4	1,05%	2.704	0,34%

Sector Code (Level 55)	Product Description (Level 55)	IPI REDUCTION MULTIPLIER	IPI Collected on Final Demand	Î	Df(2008)	Df1	X1	'+X1 (%)	'+L1	'+C1	Df2	'+X2 (%)	'+L2	'+C2(%X)
328	Material eletrônico e equipamentos de comunicações	0%	1.854,1	0,0	21.097,1	21.097,1	32.744,1	0,06%	49	0,00%	21.097,1	0,14%	122	0,00%
329	Aparelhos/instrumentos médico-hospitalar, medida e óptico	0%	1.137,1	0,0	12.617,5	12.617,5	15.201,5	0,10%	130	0,00%	12.617,5	0,21%	289	0,00%
330	Automóveis, camionetas e utilitários	61%	5.652,7	3.448,1	84.043,6	87.491,7	91.476,8	4,06%	3.676	4,10%	91.693,9	9,01%	8.158	9,10%
331	Caminhões e ônibus	76%	200,9	152,7	27.457,0	27.609,7	30.438,3	0,56%	138	0,56%	28.982,5	5,34%	1.323	5,56%
332	Peças e acessórios para veículos automotores	0%	18,1	0,0	15.020,7	15.020,7	74.262,8	1,33%	4.596	0,00%	15.020,7	3,48%	12.024	0,00%
333	Outros equipamentos de transporte	0%	264,9	0,0	27.205,8	27.205,8	37.190,2	0,01%	18	0,00%	27.205,8	0,04%	44	0,00%
334	Móveis e produtos das indústrias diversas	5%	2.529,6	126,5	35.405,3	35.531,7	44.686,6	0,31%	2.933	0,36%	35.531,7	0,34%	3.235	0,36%
401	Eletricidade e gás, água, esgoto e limpeza urbana	0%	0,0	0,0	50.561,3	50.561,3	165.313,5	0,13%	530	0,00%	50.561,3	0,31%	1.284	0,00%
501	Construção	0%	0,0	0,0	204.905,2	204.905,2	243.016,8	0,02%	1.275	0,00%	204.905,2	0,04%	3.014	0,00%
601	Comércio	0%	0,0	0,0	267.799,3	267.799,3	457.683,9	0,12%	18.710	0,00%	267.799,3	0,29%	45.479	0,00%
701	Transporte, armazenagem e correio	0%	0,0	0,0	109.451,2	109.451,2	262.500,3	0,14%	6.206	0,00%	109.451,2	0,35%	15.039	0,00%
801	Serviços de informação	0%	0,0	0,0	55.101,8	55.101,8	193.831,9	0,11%	2.009	0,00%	55.101,8	0,26%	4.770	0,00%
901	Intermediação financeira e seguros	0%	0,0	0,0	118.714,0	118.714,0	278.069,3	0,13%	1.229	0,00%	118.714,0	0,32%	3.033	0,00%
1001	Serviços imobiliários e aluguel	0%	0,0	0,0	188.168,1	188.168,1	226.999,6	0,02%	120	0,00%	188.168,1	0,04%	289	0,00%
1101	Serviços de manutenção e reparação	0%	0,0	0,0	20.484,7	20.484,7	36.125,8	0,05%	977	0,00%	20.484,7	0,12%	2.372	0,00%
1102	Serviços de alojamento e alimentação	0%	0,0	0,0	87.199,9	87.199,9	104.332,0	0,02%	602	0,00%	87.199,9	0,04%	1.434	0,00%
1103	Serviços prestados às empresas	0%	0,0	0,0	39.117,3	39.117,3	209.218,8	0,14%	7.176	0,00%	39.117,3	0,35%	17.720	0,00%
1104	Educação mercantil	0%	0,0	0,0	43.171,3	43.171,3	46.185,3	0,00%	71	0,00%	43.171,3	0,01%	172	0,00%
1105	Saúde mercantil	0%	0,0	0,0	86.712,8	86.712,8	89.744,7	0,01%	94	0,00%	86.712,8	0,01%	227	0,00%
1106	Serviços prestados às famílias e associativas	0%	0,0	0,0	91.968,8	91.968,8	111.390,0	0,03%	1.280	0,00%	91.968,8	0,07%	3.104	0,00%
1107	Serviços domésticos	0%	0,0	0,0	30.846,0	30.846,0	30.846,0	0,00%	0	0,00%	30.846,0	0,00%	0	0,00%
1201	Educação pública	0%	0,0	0,0	129.529,7	129.529,7	129.913,6	0,00%	19	0,00%	129.529,7	0,00%	47	0,00%
1202	Saúde pública	0%	0,0	0,0	83.566,4	83.566,4	83.571,0	0,00%	0	0,00%	83.566,4	0,00%	0	0,00%
1203	Serviço público e seguridade social	0%	0,0	0,0	388.352,3	388.352,3	401.457,4	0,01%	307	0,00%	388.352,3	0,01%	750	0,00%
	TOTAL		26.284,0	4.409,2	3.045.610,3	3.050.019,6	5.319.033,3	0,20%	69.444	0,14%	3.056.214,3	0,48%	162.556	0,35%

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